PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 01 February 2000 (01.02.00)	
International application No. PCT/FI99/00395	**Applicant's or agent's file reference** 47967
International filing date (day/month/year) 11 May 1999 (11.05.99)	**Priority date** (day/month/year) 11 May 1998 (11.05.98)
Applicant HURME, Harri et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

07 December 1999 (07.12.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

F. Baechler

Telephone No.: (41-22) 338.83.38

09/700298
5000
Translation

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

10

Applicant's or agent's file reference 9823866-SnNK	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/EP99/03423	International filing date (*day/month/year*) 18 May 1999 (18.05.99)	Priority date (*day/month/year*) 28 May 1998 (28.05.98)
International Patent Classification (IPC) or national classification and IPC C09C 1/00		
Applicant MERCK PATENT GMBH		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
01 December 1999 (01.12.99)	24 July 2000 (24.07.2000)
Name and mailing address of the IPEA/EP Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/EP99/03423

I. Basis of the report

1. This report has been drawn on the basis of (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

☐ the international application as originally filed.

☒ the description, pages 1-8, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☒ the claims, Nos. 1-7, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. _____, filed with the letter of _____,
Nos. _____, filed with the letter of _____.

☐ the drawings, sheets/fig _____, as originally filed,
sheets/fig _____, filed with the demand,
sheets/fig _____, filed with the letter of _____,
sheets/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	7	YES
	Claims	1-6	NO
Inventive step (IS)	Claims		YES
	Claims	1-7	NO
Industrial applicability (IA)	Claims	1-7	YES
	Claims		NO

2. Citations and explanations

1) The following documents are referred to:

D1: DE-A-196 14 636 (BASF AG) 16 October 1997 (1997-10-16)

D2: DE-A-196 14 637 (BASF AG) 16 October 1997 (1997-10-16) cited in the application

D3: DE-A-42 40 511 (MERCK PATENT GMBH) 9 June 1994 (1994-06-09) cited in the application

2) Novelty - PCT Article 33(1) and (2)

Independent Claim 1 does not appear to be novel in relation to D1 and D2. D1 mentions pigment mixtures containing SiO_2 flakes coated with TiO_2 (column 4, lines 49 and 52). Lustre pigments are also mentioned as an additional component of the pigment mixtures (column 4, line 41). Consequently, the pigment mixture defined in Claim 1 can no longer be considered novel.

The SiO_2 flakes coated with TiO_2 and/or Fe_2O_3 claimed in Claim 2 are described in D2 (column 2, line 63, and column 3, line 56). This claim can therefore no longer be considered novel.

Claim 3 defines a pigment mixture in which metal flakes and other base materials are used, coated with one or more metal oxides. Similar components are described in D1 (column 4, lines 42-44) and D2 (column 6, lines 12-14). Consequently, the subject matter of Claim 3 can not be considered novel.

Claim 4 specifies the proportions in which the two components of the pigment mixture are used. In their present form, Claims 1 and 4 indicate that the two components A and B can be identical and may therefore be used in a 1:1 ratio. However, that mixture is already covered by Claim 1, which is not considered to be novel.

Furthermore, D3 (page 4, Examples 1 and 2) describes pigment mixtures in which the two components - SiO_2 flakes coated with TiO_2 and Iriodin[SPEC0416] as an effect pigment - are used in equal proportions. Consequently, not only the subject matter of the generally worded Claims 1-3, 5 and 6, but also that of Claim 4, which defines a specific range for the ratio of component A / component B, is deprived of novelty by D3.

Regardless of that disclosure, the possible uses listed in Claim 5 are, for the most part, mentioned in D1 (column 5, lines 6-9), D2 (column 6, line 68, to column 7, line 6) and D3 (page 2, lines 56-57). Claim 5 is therefore not considered novel.

The composition defined in Claim 6 can consist of the pigment mixture alone, without additional components. However, that composition is already covered by Claim 1. For the above-mentioned reasons,

this embodiment is not considered to be novel, and it also leads to a double claim for protection in respect of the same subject matter in two independent claims, namely Claims 1 and 2.

3) Inventive Step - PCT Article 33(1) and (3)

The technical problem addressed by the present invention is that of achieving high covering power using pigment compositions containing SiO_2 substrates as the base material to carry other materials (page 1, lines 29-31). In addition, the colour should be provided by interference colours, and the required opacity should be obtained by coating with nano-particles (page 3, lines 7-14). "Component B", an "effect pigment" which is mentioned in the claims, is not sufficiently defined, i.e. as an interference pigment. At present, the wording is not confined to pigments which yield interference colours, and it therefore also covers conventional colour particles, including particles of type A.

D3 is considered to represent the closest prior art.

The aim of improving the covering power of the disclosed pigment is not mentioned expressly in D3. Instead, the object is to improve the pigment mixture with regard to the gloss effect of the interference colour (D3, page 2, lines 40-49). To that end, D3 proposes a pigment mixture which includes the essential features of the pigment mixture disclosed in the present application (cf. explanation regarding novelty, above). Improvement of the covering power represents a necessary

incidental "bonus-effect". Consequently, even new pigment variants, the novelty of which is based on ordinary features (PCT Article 33(2)), as in Claim 7 (see above), are not considered to be inventive (PCT Article 33(3)).

Claim 7 defines a preparation in which a binder is added to a pigment mixture. That addition is considered to be conventional for a range of typical preparations, such as varnishes and paints, and it therefore demands no inventive input of a person skilled in the art.

Moreover, the pigment mixtures disclosed in Claims 1-3 have already been described in earlier publications (D1, D2). Consequently, these claims can not be considered to involve an inventive step.

The mixture ratios defined in Claim 4 and the formulation disclosed in Claim 6 are already covered by Claim 1 and, in the case of Claim 4, disclosed in D3. Since neither claim is novel, they can not be considered inventive.

The features mentioned in Claim 5 (use of the pigment mixture) have simply been selected amongst a number of obvious alternatives from which a person skilled in the art would choose, according to the circumstances in question, without exercising inventive skill. Consequently, even new possible uses, such as the coloration of seeds or foodstuffs, can not be considered to involve an inventive step.

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

a. Contrary to the requirements of PCT Rule 5.1(a)(ii), neither the relevant prior art disclosed in D1 nor that document itself has been mentioned in the description.

b. The terms "Monastralgrün" and "Cappoxytgelb", which appear in the description (page 6, Example 1), appear to be registered trademarks which have not been acknowledged as such.

c. The term "educate" [*Erziehung*] (page 3, line 7) is presumably a typing error.

d. The symbol "%" (page 6, Example 1) has not been identified as meaning vol.% or wt.%.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

a. The expression "substantially solvent-free" (Claim 7) is imprecise.

b. Contrary to the requirements of PCT Article 6, Claim 5 is not supported by the description, because its scope is broader than the scope determined by the description. The reasons for that finding are as follows:
- "seed coloration" is broader in scope than the "seed coating" to which the description refers (page 4, line 10).
"food enhancement" is broader in scope than the "food dyeing" to which the description refers (page 4, line 11).

c. On page 7, line 36, the meaning of "to 100.00% water" is unclear.

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PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/FI99/00395

International Filing Date 11 MAY 1999 (11.05.99)

The Finnish Patent Office
PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 47967

Box No. I TITLE OF INVENTION

Method and system for detecting a signal having a certain frequency

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

TELLABS OY
Sinikalliontie 7, FIN-02630 Espoo, Finland

☐ This person is also inventor.

Telephone No.: +358-9-413121

Facsimile No.: +358-9-41312815

Teleprinter No.:

State *(that is, country)* of nationality: Finland

State *(that is, country)* of residence: Finland

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

HURME, Harri
Kaskenkaatajantie 18 C, FIN-02100 Espoo, Finland

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Finland

State *(that is, country)* of residence: Finland

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BERGGREN OY AB
P.O. Box 16, FIN-00101 Helsinki, Finland

Telephone No.: +358-9-693701

Facsimile No.: +358-9-6933944

Teleprinter No.:

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

TAMMINEN, Timo M.
Puustellinpolku 8 C 8, FIN-00410 Helsinki,
Finland

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Finland

State *(that is, country)* of residence: Finland

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☒ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

KOSKELA, Jari
Mäkelänkatu 4d A 6, FIN-00510 Helsinki,
Finland

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Finland

State *(that is, country)* of residence: Finland

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☒ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☐ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☐ the United States of America only
- ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☒ AP **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☒ AL Albania .....
- ☒ AM Armenia .....
- ☒ AT Austria .....
- ☒ AU Australia .....
- ☒ AZ Azerbaijan
- ☒ BA Bosnia and Herzegovina .....
- ☒ BB Barbados
- ☒ BG Bulgaria .....
- ☒ BR Brazil .....
- ☒ BY Belarus .....
- ☒ CA Canada
- ☒ CH and LI Switzerland and Liechtenstein
- ☒ CN China .....
- ☒ CU Cuba .....
- ☒ CZ Czech Republic .....
- ☒ DE Germany .....
- ☒ DK Denmark .....
- ☒ EE Estonia .....
- ☒ ES Spain .....
- ☒ FI Finland .....
- ☒ GB United Kingdom
- ☒ GD Grenada
- ☒ GE Georgia .....
- ☒ GH Ghana .....
- ☒ GM Gambia
- ☒ HR Croatia .....
- ☒ HU Hungary .....
- ☒ ID Indonesia
- ☒ IL Israel .....
- ☒ IN India .....
- ☒ IS Iceland
- ☒ JP Japan .....
- ☒ KE Kenya .....
- ☒ KG Kyrgyzstan .....
- ☒ KP Democratic People's Republic of Korea .....
- ☒ KR Republic of Korea .....
- ☒ KZ Kazakhstan .....
- ☒ LC Saint Lucia
- ☒ LK Sri Lanka
- ☒ LR Liberia
- ☒ LS Lesotho .....
- ☒ LT Lithuania
- ☒ LU Luxembourg
- ☒ LV Latvia
- ☒ MD Republic of Moldova .....
- ☒ MG Madagascar .....
- ☒ MK The former Yugoslav Republic of Macedonia .....
- ☒ MN Mongolia
- ☒ MW Malawi .....
- ☒ MX Mexico .....
- ☒ NO Norway
- ☒ NZ New Zealand .....
- ☒ PL Poland .....
- ☒ PT Portugal .....
- ☒ RO Romania
- ☒ RU Russian Federation .....
- ☒ SD Sudan
- ☒ SE Sweden
- ☒ SG Singapore
- ☒ SI Slovenia .....
- ☒ SK Slovakia .....
- ☒ SL Sierra Leone
- ☒ TJ Tajikistan .....
- ☒ TM Turkmenistan .....
- ☒ TR Turkey .....
- ☒ TT Trinidad and Tobago .....
- ☒ UA Ukraine .....
- ☒ UG Uganda .....
- ☒ US United States of America .....
- ☒ UZ Uzbekistan .....
- ☒ VN Viet Nam .....
- ☒ YU Yugoslavia .....
- ☒ ZW Zimbabwe .....

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☒ AE United Arab Emirates .....
- ☒ ZA Republic of South Africa .....
- ☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 11 May 1998 (11.05.1998)	981038	Finland (FI)		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*
ISA / SE

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*
Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	: 4
description (excluding sequence listing part)	: 8
claims	: 2
abstract	: 1
drawings	: 3
sequence listing part of description	:
Total number of sheets	: 18

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify)*: Copy of office action in FI 981038.

Figure of the drawings which should accompany the abstract: 3

Language of filing of the international application: Finnish

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

BERGGREN OY AB

Markus Levlin
Patent Agent

Helsinki, 11 May 1999

For receiving Office use only

1. Date of actual receipt of the purported international application: 11 MAY 1999 (11-05-1999)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA / SE
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 15 JUNE 1999 (15.06.99)

Menetelmä ja laite tietyntaajuisen signaalin ilmaisemiseksi [- ~~Metod och apparat för att detektera en signal med viss frekvens~~]

Keksintö koskee yleisesti signaali-ilmaisua eli sen toteamista, esiintyykö tietyssä johdinyhteydessä tietyllä taajuudella muuttuva signaali vai ei. Erityisesti keksintö koskee signaali-ilmaisua analogisessa puhelinlinjassa.

Tiedonsiirtotekniikassa on usein tarve ilmaista, onko tietyllä taajuudella muuttuva jännite- ja/tai virtasignaali läsnä tietyssä johdinyhteydessä vai ei. Esimerkkinä voidaan tarkastella puhelinjärjestelmää, jossa analoginen puhelinkeskus lähettää maksunosoitussykäyksiä eli ns. laskutussykäyksiä lyhyinä signaalipulsseina, joiden taajuus on järjestelmästä riippuen yleensä joko 12 kHz tai 16 kHz. Puhelinjärjestelmän muun laitteen, joka voi olla esimerkiksi analogista puhelinkonetta simuloiva ns. OLIC-piiri (Office Line Interface Circuit), on kyettävä havaitsemaan laskutussykäykset virheettömästi, mikä tarkoittaa, että kaikki laskutussykäykset on ilmaistava, mutta muiden signaalien perusteella ei saa antaa aiheetonta ilmaisua.

Perinteinen lähestymistapa tietyntaajuisen signaalin ilmaisemiseksi on käyttää kuvan 1 mukaisesti kahta sarjaan kytkettyä piirielintä 101 ja 102, joista signaalin kulkusuuntaan nähden ensimmäinen on kaistanpäästösuodatin tai vastaava taajuusherkkä piirielin 101 ja jälkimmäinen on sinänsä taajuudelle epäherkkä tasonilmaisin 102. Suodattimella 101 on tietty taajuusvaste, jossa päästökaistan keskitaajuus on sama kuin haluttu ilmaistava signaalitaajuus. Tasonilmaisimen 102 lähdön tila on aktiivinen, kun suodattimen 101 läpi tulee riittävän suuritasoinen signaali, ja passiivinen muuten. Kuvan 1 esittämässä järjestelyssä on paljon haittapuolia. Suodattimen 101 taajuusvasteen saaminen halutuksi voi olla työlästä ja se voi edellyttää suurikokoisen ja/tai monimutkaisen suodattimen käyttöä. Kaistanpäästösuodattimen päästökaistan merkittävä siirtäminen on hankalaa, joten jos muuten samaa laitetta haluttaisiin käyttää valinnan mukaan joko 12 kHz:n tai 16 kHz:n signaalin ilmaisemiseen, suodatin 101 voi olla tarpeen vaihtaa valinnan yhteydessä.

Patenttihakemuksesta numero FI-944857 tunnetaan kuvan 2 mukainen kehittyneempi järjestely tietyntaajuisen signaalin detektoimiseksi. Parikaapelissa 201 kulkeva jännitesignaali vahvistetaan vahvistimessa 202 ja syötetään erotuskondensaattorin 203 kautta demultiplekseriin 204, jota ohjaa kellosignaali CLK. Kellosignaalin ohjaamana demultiplekseri 204 kytkee saamansa jännitesignaalin syklisesti vuorotellen vain yhteen lähdöistä 205 - 208 kerrallaan. Alipäästösuodattimet 209 - 212 suodat-

tavat kuhunkin lähtöön kytketyn jännitesignaalin oleellisesti tasajännitteeksi. Komparaattori 213 suorittaa vertailuja suodatettujen tasajännitesignaalien välillä ja antaa lähtösignaalin det0, jos tiettyjen suodattimien lähtöjen välillä on riittävän suuri ero.

Kuvan 2 mukaisessa ratkaisussa ajatuksena on se, että kun kellosignaalin CLK taajuus on tasan neljä kertaa halutun ilmaistavan signaalin taajuus, demultiplekseri 204 ehtii kytkeä jännitesignaalin kerran kuhunkin lähtöön ilmaistavan signaalin yhden jakson aikana. Jaksosta toiseen se ilmaistavan signaalin osa, joka kytketään tiettyyn lähtöön, pysyy muuttumattomana. Tällöin suodattimet 209 - 212 muodostavat eritasoisia tasajännitteitä sen mukaan, mikä osa ilmaistavan signaalin aaltomuodosta kytkeytyy mihinkäkin lähtöön. Komparaattorilla 213 havaitaan, että suodattimien 209 - 212 tuottamat jännitteet eroavat toisistaan. Jos parikaapelissa 201 ei ole haluttua ilmaistavaa signaalia, mutta on sen sijaan jonkin muun taajuinen signaali, demultiplekserin 204 tiettyyn lähtöön kytkeytyvä signaalin aaltomuodon osa muuttuu jaksosta toiseen. Tällöin jokaiseen suodattimeen 209 - 212 kytkeytyy muuttuva jännitesignaali, joka ei etene suodattimen läpi. Komparaattori 213 näkee kaikkien suodattimien lähdöt oleellisesti samanlaisina, jolloin se ei anna lähtösignaalia.

Kuvan 2 mukaisessa järjestelyssä haittapuolena on se, että ilmaistava signaali joudutaan johtamaan sekä demultiplekserin että suodattimien läpi, mikä voi aiheuttaa merkittävää signaalin vaimentumista ja häviöitä, jotka aiheuttavat piirin lämpenemistä käytön aikana. Piirin toiminnan kannalta on oleellista, että suodattimien 209 - 212 taajuusvasteet ovat hyvin tarkasti samanlaiset, mikä edellyttää suhteellisen kalliiden, viritettyjen suodattimien käyttöä. Lisäksi järjestely soveltuu vain jännitesignaalien ilmaisemiseen.

Esillä olevan keksinnön tavoittena on esittää sellainen menetelmä ja järjestelmä tietyntaajuisen signaalin ilmaisemiseksi, jossa edellä selostettuja, tekniikan tasolle ominaisia haittoja pystytään vähentämään tai poistamaan.

Keksinnön tavoitteet saavutetaan kytkemällä ilmaistava signaali rinnakkaisiin energiaa varastoiviin komponentteihin, jotka toimivat tahdistetusti ja joiden antoja voidaan vertailla eri tavoin.

Keksinnön mukaiselle laitteelle on tunnusomaista, että että se käsittää
- johdinyhteyteen rinnan kytketyt ainakin kolme energiaa varastoivaa komponenttia,
- kytkinvälineet yhteyden muodostamiseksi valikoidusti kustakin energiaa varastoivasta komponentista tiettyyn referenssiin,
- välineet kytkinvälineiden ohjaamiseksi ennalta määrätyllä taajuudella ja

- välineet tietyn, varastoituneeseen energiaan verrannollisen suureen mittaamiseksi kustakin energiaa varastoivasta komponentista.

Keksintö kohdistuu myös menetelmään, jolle on tunnusomaista, että se käsittää vaiheet, joissa

- johdetaan signaali ainakin kolmelle, rinnan kytketylle energiaa varastoivalle komponentille,
- kytketään säännöllisesti kukin energiaa varastoiva komponentti tiettyyn referenssiin ja
- mitataan tietyn, varastoituneeseen energiaan verrannollisen suureen arvo kustakin energiaa varastoivasta komponentista.

Keksinnön mukaisesti signaali, joka saattaa sisältää ilmaistavan signaalin, kytketään rinnakkaisiin energiaa varastoiviin komponentteihin, jotka ovat esimerkiksi kapasitansseja tai induktansseja ja joiden määrää ei sinänsä ole rajoitettu, mutta joita on keksinnön edullisessa suoritusmuodossa neljä. Energiaa varastoivien komponenttien toiminta on tahdistettu siten, että kussakin niistä muodostuvaa signaalia poikkeutetaan kytkemällä anto tietyksi ajaksi kerrallaan ennalta määrättyyn poikkeuttavaan vakiotasoon. Kytkentähetket, jolloin poikkeutus tapahtuu, vaihtuvat syklisesti tietyllä taajuudella energiaa varastoivasta komponentista toiseen. Poikkeutustaajuus on verrannollinen sen signaalin taajuuteen, jota halutaan ilmaista. Mikäli ilmaistava signaali on läsnä, poikkeutus aiheuttaa vakiosuuruiset erot tiettyjen, pareittain määriteltyjen energiaa varastoivien komponenttien antojen välille. Antoihin kytketyillä komparaattoreilla havaitaan mahdolliset vakiosuuruiset erot. Komparaattoreita voidaan kytkeä yhteen eri tavoin ilmaisun selkeyden parantamiseksi.

Keksinnön mukaisessa ratkaisussa ilmaistava signaali ei etene demultiplekserin läpi kuten hakemuksen FI-944857 mukaisessa ratkaisussa eikä keksintö myöskään edellytä välttämättä suodattimien käyttöä signaalin kulkutiellä. Havaittava taajuus voidaan helposti valita vaihtamalla edellä mainittua poikkeutustaajuutta.

Seuraavassa selostetaan keksintöä yksityiskohtaisemmin viitaten esimerkkinä esitettyihin edullisiin suoritusmuotoihin ja oheisiin kuviin, joissa

kuva 1 esittää erästä tekniikan tason mukaista ilmaisinta,

kuva 2 esittää erästä toista tekniikan tason mukaista ilmaisinta

kuva 3 esittää keksinnön erästä edullista suoritusmuotoa,

kuvat 4a ja 4b esittävät eräitä jännitemuotoja kuvan 3 suoritusmuodossa,

kuva 5 esittää keksinnön erästä toista edullista suoritusmuotoa ja

kuva 6 havainnollistaa keksinnön mukaista menetelmää.

Edellä tekniikan tason selostuksen yhteydessä on viitattu kuviin 1 ja 2, joten seuraavassa keksinnön ja sen edullisten suoritusmuotojen selostuksessa viitataan lähinnä kuviin 3 - 6. Kuvissa käytetään toisiaan vastaavista osista samoja viitenumeroita.

Kuvassa 3 on esitetty yksinkertaistettu lohkokaavio, joka kuvaa keksinnön erästä edullista suoritusmuotoa, joka soveltuu jännitesignaalin ilmaisemiseen. Signaali, josta halutaan tutkia, sisältääkö se ilmaistavan signaalin, johdetaan kuvan 3 mukaiseen kytkentään linjaa 301 pitkin ja haarautetaan rinnakkaisiin, keskenään yhtäsuuriin kapasitansseihin 302 - 305. Kunkin kapasitanssin toiselta puolelta on yhteys R:llä merkityn lohkon sekä tietyn kytkinjärjestelyn kautta referenssipotentiaaliin, joka kuvan esittämässä suoritusmuodossa on maapotentiaali. Kaikki neljä kytkinjärjestelyä on toteutettu multiplekserillä 306, jonka toimintaa ohjaavat kellosignaalit CLK1 ja CLK2. R:llä merkityt lohkot voivat olla yksinkertaisesti resistansseja tai sitten ne voivat sisältää joitakin monimutkaisempia järjestelyjä. Kaikki R-lohkot ovat kuitenkin oleellisesti samanlaisia. Kapasitansseista 302 ja 304 on lisäksi yhteys komparaattoriin 307 ja kapasitansseista 303 ja 305 on yhteys komparaattoriin 308. Komparaattorien 307 ja 308 lähdöt summataan summaimessa 309, jonka lähtösignaali on koko kytkennän lähtösignaali.

Kuvassa 3 esitetyn kytkennän toiminnan selostamiseksi oletetaan aluksi, että linjaa 301 pitkin tuleva signaali on puhdasta siniaaltoa juuri sillä taajuudella, joka halutaan ilmaista. Oletetaan lisäksi, että ilmaistava signaali on puhdasta sinimuotoista vaihtojännitettä, jolloin sen aikakeskiarvo on sama kuin kuvassa 3 esitetty referenssipotentiaali. Kapasitanssit 302 - 305 on mitoitettu niin suuriksi, että ilmaistava jännitesignaali kulkee niiden läpi, jolloin mikäli mitään yhteyttä kapasitanssien ja referenssipotentiaalin välillä ei olisi, kussakin pisteessä A, B, C ja D havaittaisiin identtinen, sinimuotoinen jännite. Multiplekserin 306 toimintaa ohjataan kellosignaalilla CLK1 ja/tai CLK2 siten, että ilmaistavan signaalin yhden jakson aikana kustakin pisteestä A, B, C ja D on kerran yhteys vastaavan R-lohkon kautta referenssipotentiaaliin. Eräs esimerkinomainen multiplekserin 306 toiminnan ajoitus on esitetty kuvassa 4a. Siinä aaltomuoto 401 esittää jännitesignaalia ilmaistavalla taajuudella ja kirjaimilla A, B, C ja D on merkitty kytkentäaikoja, joiden aikana yhteys kustakin pisteestä A, B, C ja D vastaavan R-lohkon kautta referenssipotentiaaliin on kytkettynä.

Keksinnön toiminnalle on edullista, että R-lohkojen tuloimpedanssi on merkittävästi pienempi kuin komparaattorien 307 ja 308 tuloimpedanssi. Tällöin edellä selostettu tahdistettu kytkeminen aiheuttaa sen, että kapasitansseihin 302 - 305 varastoituu eri määrä sähköenergiaa riippuen siitä, millä ilmaistavan signaalin jaksonajan hetkellä kapasitanssi kytketään R-lohkon kautta maapotentiaaliin. Esimerkiksi kuvasta 4a nähdään, että kytkentä pisteestä A eli kapasitanssista 302 vastaavan R-lohkon kautta maapotentiaaliin on kytkettynä silloin, kun ilmaistavan signaalin jännite on lähes korkeimmillaan, ja vastaavasti kytkentä pisteestä C eli kapasitanssista 304 vastaavan R-lohkon kautta maapotentiaaliin on kytkettynä silloin, kun ilmaistavan signaalin jännite on lähes matalimmillaan. Kapasitansseihin 302 ja 304 varastoituva sähköenergia näkyy tällöin siten, että pisteen A potentiaali on jatkuvasti tietyn vakion verran korkeampi kuin pisteen C potentiaali. Tilannetta voidaan kuvata myös sanomalla, että kapasitanssiin 302 integroituu tietty tasajännitekomponentti, joka on suurempi kuin kapasitanssiin 304 integroituva vastaava tasajännitekomponentti.

On huomattava, että kapasitanssit 302 ja 305 eivät kuvan 3 suoritusmuodossa toimi integraattoreina siinä mielessä, että ne muodostaisivat ilmaistavan signaalin aikaintegraalin. Edellä mainittu integroituminen tarkoittaa, että kuhunkin kapasitanssiin varastoituu tietty määrä ilmaistavasta signaalista peräisin olevaa sähkömagneettista energiaa, jonka määrä riippuu siitä, missä vaiheessa kapasitanssiin johdetun ilmaistavan signaalin jaksoa kytkentä referenssipotentiaaliin tehdään. Kuvassa 4b käyrä 410 esittää pisteen A potentiaalia ja käyrä 411 esittää pisteen C potentiaalia. Pisteiden A ja C ja maapotentiaalin välillä havaitaan siis sinimuotoisesti muuttuva jännitesignaali, jonka taajuus on sama kuin ilmaistavan signaalin taajuus, mutta eri pisteissä havaitut jännitesignaalit on poikkeutettu toisiinsa nähden tietyn vakiojännite-eron verran. Kuvaa 4a tarkastelemalla voidaan päätellä, että pisteiden B ja D välillä havaittaisiin sama ilmiö, joskin heikompana, koska niinä B:llä ja D:llä merkittyinä hetkinä, jolloin yhteys kapasitanssin 303 tai 305 ja maapotentiaalin välillä on kytkettynä, ilmaistavan signaalin itseisarvo on suhteellisen lähellä nollaa.

Kuvan 4b mukaiset signaalit voidaan johtaa kuvan 3 mukaisesti komparaattoriin 307, jonka lähtö riippuu vain sen kahden tulon välisestä potentiaalierosta eikä kummankaan tulon potentiaalin itseisarvosta. Tällaista komparaattoria luonnehditaan yleisesti sanomalla, että se on immuuni yhteismuotoisille signaaleille. Komparaattorin 307 lähtö on siis aktiivinen, kun kapasitansseihin 302 ja 304 integroituneet tasajännitekomponentit eroavat toisistaan enemmän kuin komparaattorille 307 asetetun kynnysarvon verran. Vastaavalla tavalla komparaattorin 308 lähtö on aktiivinen, kun kapasitansseihin 303 ja 305 integroituneet tasajännitekomponentit eroavat toi-

sistaan enemmän kuin komparaattorille 308 asetetun kynnysarvon verran, joka on edullisimmin sama kuin komparaattorille 307 asetettu kynnysarvo. Komparaattorien 307 ja 308 lähtösignaalien summaaminen summaimessa 309 tarkoittaa, että koko kytkennän lähtösignaali on aktiivinen, jos ainakin toisen komparaattorin lähtösignaali on aktiivinen. Tietyn signaalin aktiivinen ja passiivinen tila voidaan määritellä siten kuin kussakin kytkennässä nähdään sopivaksi; tavanomaista logiikkaa soveltavissa digitaalipiireissä aktiivinen tila vastaa yleensä bittiarvoa "1", jota kuvataan tietyllä positiivisella jännitteellä, ja passiivinen tila vastaa bittiarvoa "0", jota kuvataan lähellä maapotentiaalia olevalla jännitteellä.

Etukäteen ei voida sanoa, miten multiplekserin 306 kytkentäsykli suhtautuu ilmaistavan signaalin vaiheeseen. Kuvat 4a ja 4b vastaavat tilannetta, jossa kapasitanssiin 302 integroituva tasajännitekomponentti on suurempi kuin kapasitanssiin 304 integroituva tasajännitekomponentti, mutta ilmaistavan signaalin puolen jaksonajan suuruinen suhteellinen siirtymä signaalin ja multiplekserin kytkentäsyklin välillä kääntäisi tilanteen täsmälleen päinvastaiseksi. Tämän johdosta komparaattorit 307 ja 308 on edullista toteuttaa ns. ikkunakomparaattoreina, joiden lähtö on aktiivinen, kun tulosignaalien erotuksen itseisarvo on suurempi kuin tietty kynnysarvo, riippumatta siitä, kumpi tulosignaali on arvoltaan suurempi.

Kuvan 3 mukaisen järjestelyn taajuusherkkyyden ymmärtämiseksi tutkitaan seuraavaksi, mitä tapahtuu, jos linjaa 301 pitkin tuleva signaali ei sisällä signaalikomponenttia ilmaistavalla taajuudella. Yksinkertaisuuden vuoksi voidaan aluksi olettaa, että linjaa 301 pitkin tuleva signaali on puhdasta siniaaltoa jollakin muulla kuin ilmaistavalla taajuudella. Jos tämä jokin muu taajuus eroaa vain vähän ilmaistavasta taajuudesta, komparaattori 307 (ja samalla tavalla 308) havaitsee tulojensa välillä sinimuotoisesti muuttuvan jännite-eron, jonka taajuus on sama kuin ilmaistavan taajuuden ja linjaa 301 pitkin tulevan signaalin taajuuden erotuksen itseisarvo. Jännite-eron amplitudi riippuu kapasitanssien 302 - 305 ja R-lohkojen mitoituksesta tai tarkemmin sanottuna mitoituksen perusteella määräytyvästä aikavakiosta, joka säätelee tasajännitekomponentin integroitumista kapasitansseihin 302 - 305. Komparaattoreille 307 ja 308 asetettu kynnysarvo määrää, kuinka lähellä ilmaistavaa taajuutta linjaa 301 pitkin tulevan signaalin taajuuden on oltava, jotta ainakin toinen komparaattori antaisi aktiivisen lähtösignaalin.

Jos linjaa 301 pitkin tulevan signaalin taajuus eroaa merkittävästi ilmaistavasta taajuudesta, multiplekserin 306 kytkentäsykli on signaaliin nähden satunnainen eli ne hetket, jolloin yhteys kustakin kapasitanssista referenssipotentiaaliin on kytkettynä, eivät sijaitse mitenkään säännöllisesti linjaa 301 pitkin tulevan signaalin aaltomuo-

toon nähden. Tällöin kuhunkin kapasitanssiin 302 - 305 integroituu vain merkityksettömän pieni tasajännitekomponentti eikä kummankaan komparaattorin 307 tai 308 lähtö ole aktiivinen.

Kuva 5 esittää keksinnön vaihtoehtoista suoritusmuotoa, jossa energiaa varastoivina komponentteina 501 - 504 käytetään induktansseja, joissa sähköenergia varastoituu virran eikä jännitteen muodossa. Referenssipotentiaali (kuvassa 3 maapotentiaali) on tällöin korvattava vakiovirtageneraattorilla 505. Kuvassa 5 on lisäksi esitetty alipäästösuodattimet 506 - 509 energiaa varastoivien komponenttien 501 - 504 ja komparaattorien 307 ja 308 välillä. Suodattimilla voidaan parantaa keksinnön mukaisen laitteen toimintaa erityisesti silloin, kun komparaattorit 307 ja 308 eivät ole riittävän immuuneja yhteismuotoiselle signaalille. Vastaavanlaisia suodattimia voitaisiin sinänsä käyttää myös kuvan 3 mukaisessa ratkaisussa.

Edellä esitetyt keksinnön suoritusmuodot on luonnollisesti nähtävä vain esimerkinomaisina eikä niillä ole keksintöä rajoittavaa vaikutusta. Erityisesti on huomattava, että keksintö ei edellytä, että niiden kytkimien kytkeminen johtavaan tilaan, jotka kuvissa 3 ja 5 on esitetty toteutettaviksi yhteisellä multiplekserillä 306, tapahtuisi siten, että tasan yksi kytkin johtaa kerrallaan. Toisin sanoen yhden kytkimen kytkentäaika voi olla myös lyhyempi tai pitempi kuin yksi N:s osa ilmaistavan signaalin jaksonajasta, missä N on rinnakkaisten energiaa varastoivien komponenttien lukumäärä (kuvissa 3 ja 5 on käytetty N:n arvoa neljä); voi siis olla, että useampi kytkin johtaa samanaikaisesti tai on hetkiä, jolloin yksikään kytkin ei johda. Energiaa varastoivien komponenttien tuottamia jännite- tai virtasignaaleja on mahdollista kombinoida monin tavoin ennen niiden johtamista komparaattoreille käyttämällä esimerkiksi ns. vastusmatriisia. Rinnakkaisten energiaa varastoivien komponenttien määrä on pienimmillään kolme, jolloin tarvitaan kolme komparaattoria, joilla vertaillaan kaikkien mahdollisten kolmen parin keskinäisiä jännite- tai virtaeroja.

Multiplekserin ohjaamiseksi käytettävien kellosignaalien taajuuden on hyvä olla ohjelmoitavissa, jolloin laite voidaan sopeuttaa ilmaisemaan lähes minkä taajuista signaalia tahansa pelkästään vaihtamalla kellosignaalin taajuutta. Näytteenottoteoriasta tunnetaan ns. aliasointi-ilmiö, joka tarkoittaa sitä, että tietty näytteenottotaajuus (esillä olevassa keksinnössä tietty kellotaajuus) aiheuttaa sekä ilmaistavan signaalin havaitsemisen että sen harmonisten taajuuksien havaitsemisen. Jos harmonisista taajuuksista on haittaa, keksinnön mukaiseen laitteeseen voidaan lisätä sinänsä näytteenottoteoriasta tunnetulla tavalla ns. anti-alias-suodatin. Toisaalta joissakin sovelluksissa voi olla jopa hyötyä siitä, että samalla laitteella pystytään havaitsemaan sekä tietty perustaajuus että sen harmoniset monikerrat.

Komparaattorien käyttämät kynnysarvot voidaan myös järjestää ohjelmoitaviksi. Edelleen voidaan esittää muunneltu suoritusmuoto, jossa koko laitteen lähtösignaali johdetaan sinänsä tunnetulla tavalla takaisinkytkettynä vaikuttamaan komparaattorien käyttämien kynnyssignaalien arvoihin, jolloin laitteen toimintaan saadaan ns. hystereesiä.

Keksinnön mukainen laite voidaan valmistaa halvoista, tavallisista erilliskomponenteista tai se voidaan toteuttaa osana mikropiiriä tai omana mikropiirinään.

Kuva 6 esittää keksinnön mukaista menetelmää vuokaavion muodossa. Tilan 601 mukainen kellotaajuuden asetus voidaan tehdä aina silloin, kun halutaan asettaa uusi ilmaistava signaalitaajuus, muulloin tila 601 voidaan sivuuttaa. Tila 602 vastaa signaalin johtamista rinnakkaisiin kapasitansseihin tai muihin energiaa varastoiviin komponentteihin, tila 603 vastaa vuorotellen tehtäviä kytkentöjä rinnakkaisista kapasitansseista tai vastaavista referenssipotentiaaliin tai -virtaan ja tila 604 vastaa jännite- tai virtaerojen mittausta, johon voi sisältyä suodatusta ja kombinointia. Tilassa 605 tehdään päätös siitä, onko mittauksessa havaittu sellainen ero, joka on suurempi kuin asetettu kynnysarvo. Päätöksen mukaan paluu alkutilaan tapahtuu joko tilan 606 tai tilan 607 kautta. Mikäli käytetään hystereesiä komparaattorien käyttämien kynnysarvojen säätämiseen, vuokaavioon tulee lisäksi tietty takaisinkytkentä tiloista 606 ja 607 tilaan 605.

Patenttivaatimukset

1. Sähköinen laite tietyntaajuisen signaalin (401) läsnäolon ilmaisemiseksi johdinyhteydessä (301), **tunnettu** siitä, että se käsittää
- mainittuun johdinyhteyteen rinnan kytketyt ainakin kolme energiaa varastoivaa komponenttia (302, 303, 304, 305; 501, 502, 503, 504),
- kytkinvälineet (306) yhteyden muodostamiseksi valikoidusti kustakin energiaa varastoivasta komponentista tiettyyn referenssiin,
- välineet (CLK1, CLK2) mainittujen kytkinvälineiden ohjaamiseksi ennalta määrätyllä taajuudella ja
- välineet (307, 308, 309) tietyn, varastoituneeseen energiaan verrannollisen suureen mittaamiseksi kustakin energiaa varastoivasta komponentista.

2. Patenttivaatimuksen 1 mukainen laite, **tunnettu** siitä, että mainitut kytkinvälineet (306) on järjestetty muodostamaan yhteys kustakin energiaa varastoivasta komponentista referenssiin kerran mainitun ilmaistavan signaalin jaksonajan aikana.

3. Patenttivaatimuksen 2 mukainen laite, **tunnettu** siitä, että mainitut energiaa varastoivat komponentit ovat kapasitansseja (302, 303, 304, 305), jolloin
- mainitut välineet (307, 308, 309) varastoituneeseen energiaan verrannollisen suureen mittaamiseksi käsittävät välineet (307, 308) jännite-eron mittaamiseksi kapasitanssien välillä ja
- mainittu referenssi on tietty vakiopotentiaali.

4. Patenttivaatimuksen 3 mukainen laite, **tunnettu** siitä, että se käsittää energiaa varastoivina komponentteina neljä kapasitanssia (302, 303, 304, 305), jolloin välineet jännite-eron mittaamiseksi kapasitanssien välillä on järjestetty mittaamaan jännite-ero ensimmäisen (302) ja kolmannen (304) kapasitanssin välillä ja toisen (303) ja neljännen (305) kapasitanssin välillä, missä kapasitanssien järjestys on se järjestys, jossa kytkinvälineet on järjestetty muodostamaan yhteys kustakin kapasitanssista vakiopotentiaaliin.

5. Patenttivaatimuksen 2 mukainen laite, **tunnettu** siitä, että mainitut energiaa varastoivat komponentit ovat induktansseja (501, 502, 503, 504), jolloin
- mainitut välineet (307, 308, 309) varastoituneeseen energiaan verrannollisen suureen mittaamiseksi käsittävät välineet (307, 308) virtaeron mittaamiseksi induktanssien välillä ja
- mainittu referenssi on tietty vakiovirta (505).

6. Patenttivaatimuksen 1 mukainen laite, **tunnettu** siitä, että se käsittää lisäksi suodatinvälineet (506, 507, 508, 509) mainitun varastoituneeseen energiaan verrannollisen suureen suodattamiseksi ennen sen mittaamista.

7. Menetelmä tietyntaajuisen signaalin läsnäolon ilmaisemiseksi johdinyhteydessä, **tunnettu** siitä, että se käsittää vaiheet, joissa
- johdetaan signaali ainakin kolmelle, rinnan kytketylle energiaa varastoivalle komponentille (602),
- kytketään säännöllisesti kukin energiaa varastoiva komponentti tiettyyn referenssiin (603) ja
- mitataan tietyn, varastoituneeseen energiaan verrannollisen suureen arvo kustakin energiaa varastoivasta komponentista (604, 605).

8. Patenttivaatimuksen 7 mukainen menetelmä, **tunnettu** siitä, että siinä kytketään kukin energiaa varastoiva komponentti referenssiin kerran ilmaistavan signaalin jaksonajan aikana.

9. Patenttivaatimuksen 8 mukainen menetelmä, **tunnettu** siitä, että parillinen määrä energiaa varastoivia komponentteja kytketään referenssiin ilmaistavan signaalin jaksonajan aikana vuorotellen järjestyksessä ensimmäisestä N:nteen, missä N on parillinen luku, ja varastoituneen energiaan verrannollisen suureen arvon mittauksessa verrataan keskenään ensimmäiseen ja (N/2 + 1):nteen komponenttiin liittyvää arvoa, toiseen ja (N/2 + 2):nteen komponenttiin liittyvää arvoa ja niin edelleen aina i:nteen ja (N/2 + i):nteen komponenttiin liittyvää arvoa, kunnes (N/2 + i) = N.

10. Patenttivaatimuksen 7 mukainen menetelmä, **tunnettu** siitä, että siinä lisäksi suodatetaan mainittua varastoituneeseen energiaan verrannollisen suureen arvoa ennen sen mittaamista.

(57) Tiivistelmä

Sähköinen laite on tarkoitettu tietyntaajuisen signaalin (401) läsnäolon ilmaisemiseksi johdinyhteydessä (301). Se käsittää
- mainittuun johdinyhteyteen rinnan kytketyt ainakin kolme energiaa varastoivaa komponenttia (302, 303, 304, 305; 501, 502, 503, 504),
- kytkinvälineet (306) yhteyden muodostamiseksi valikoidusti kustakin energiaa varastoivasta komponentista tiettyyn referenssiin,
- välineet (CLK1, CLK2) mainittujen kytkinvälineiden ohjaamiseksi ennalta määrätyllä taajuudella ja
- välineet (307, 308, 309) tietyn, varastoituneeseen energiaan verrannollisen suureen mittaamiseksi kustakin energiaa varastoivasta komponentista.

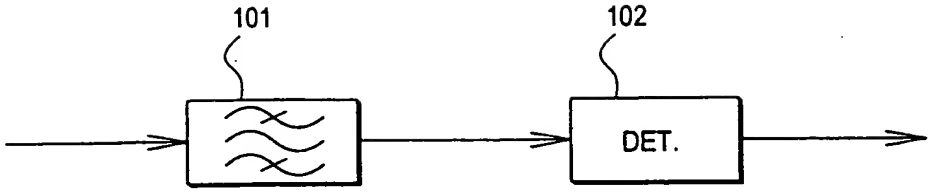

Fig. 1
PRIOR ART

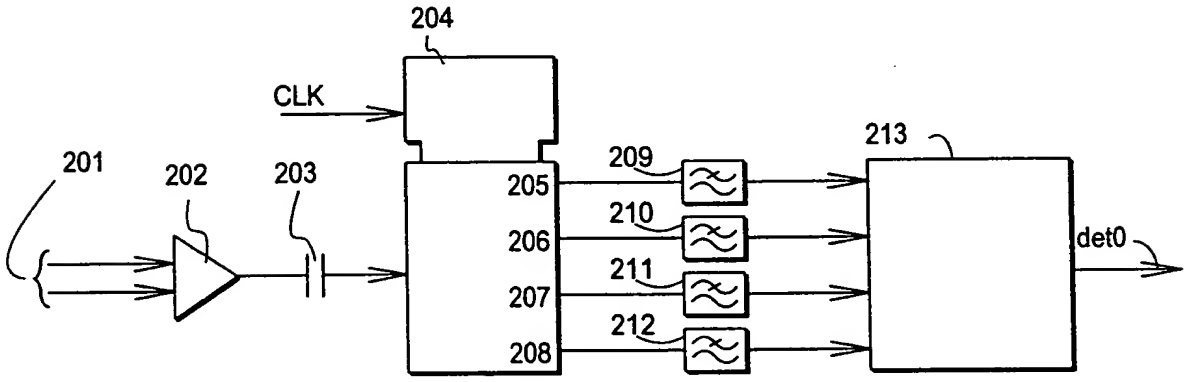

Fig. 2
PRIOR ART

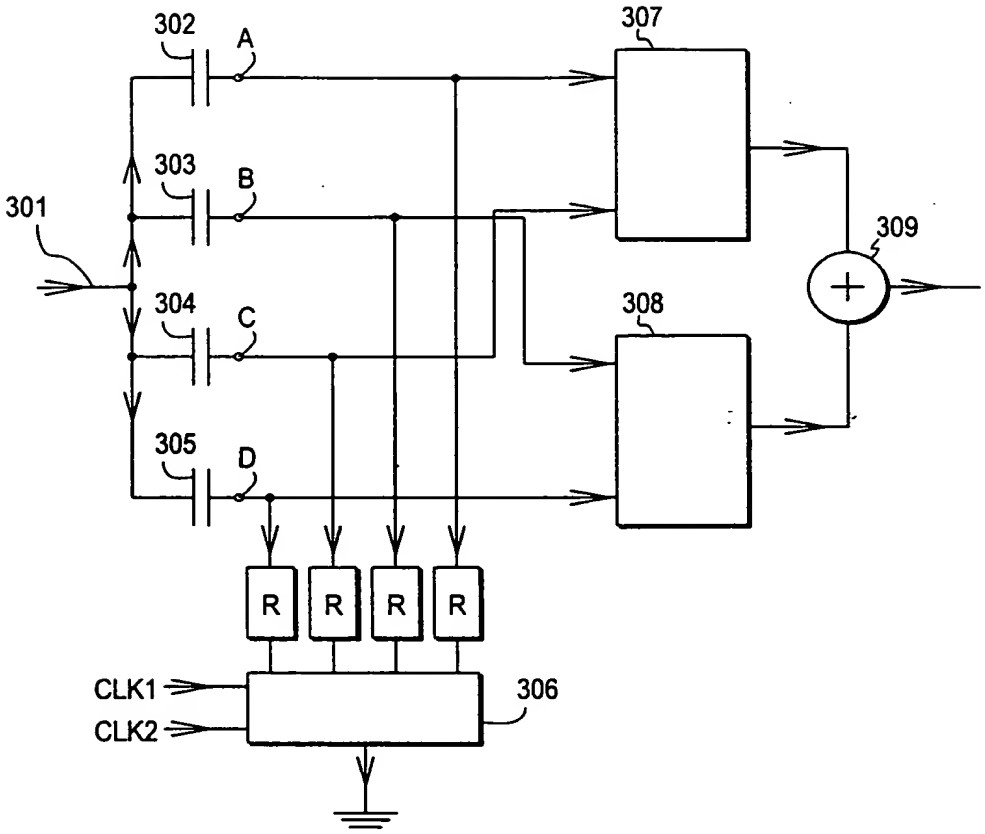

Fig. 3

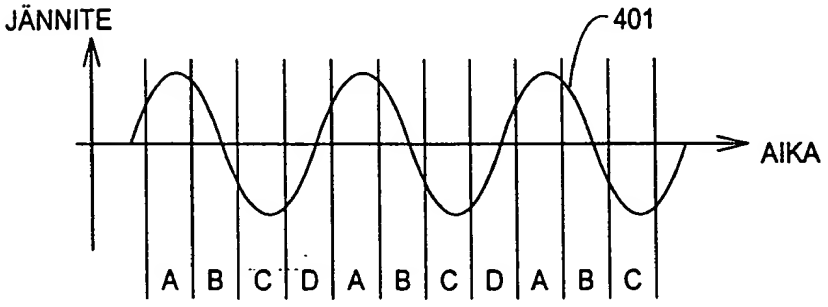

Fig. 4a

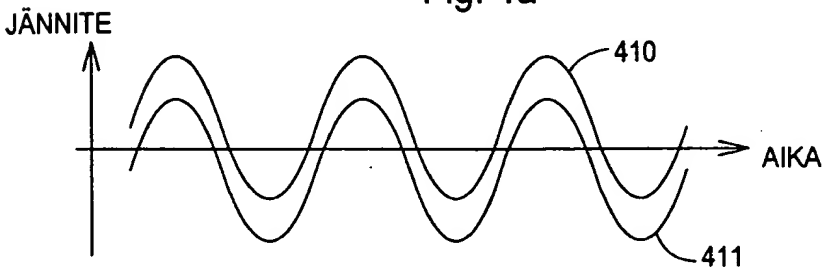

Fig. 4b

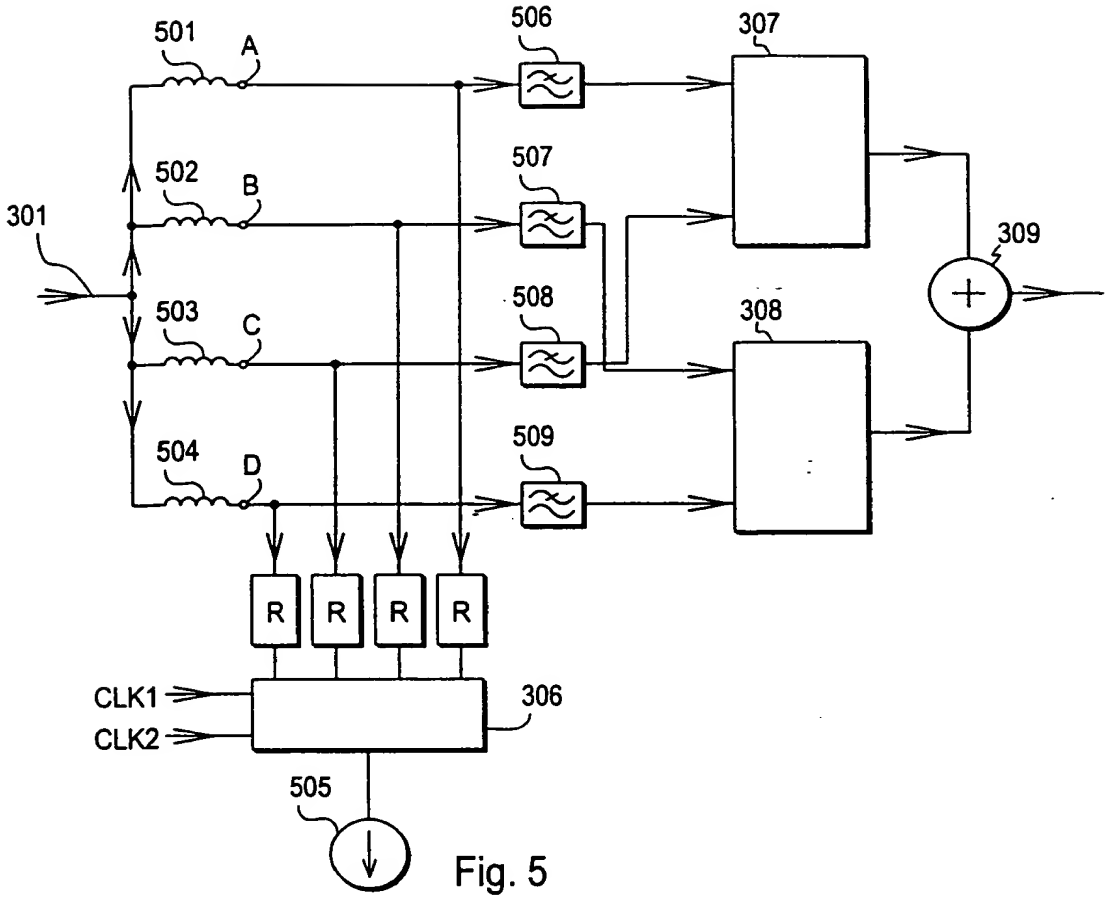
501
A
506
307
502
B
507
301
309
503
C
508
308
504
D
509
R
R
R
R
CLK1
CLK2
306
505

Fig. 5

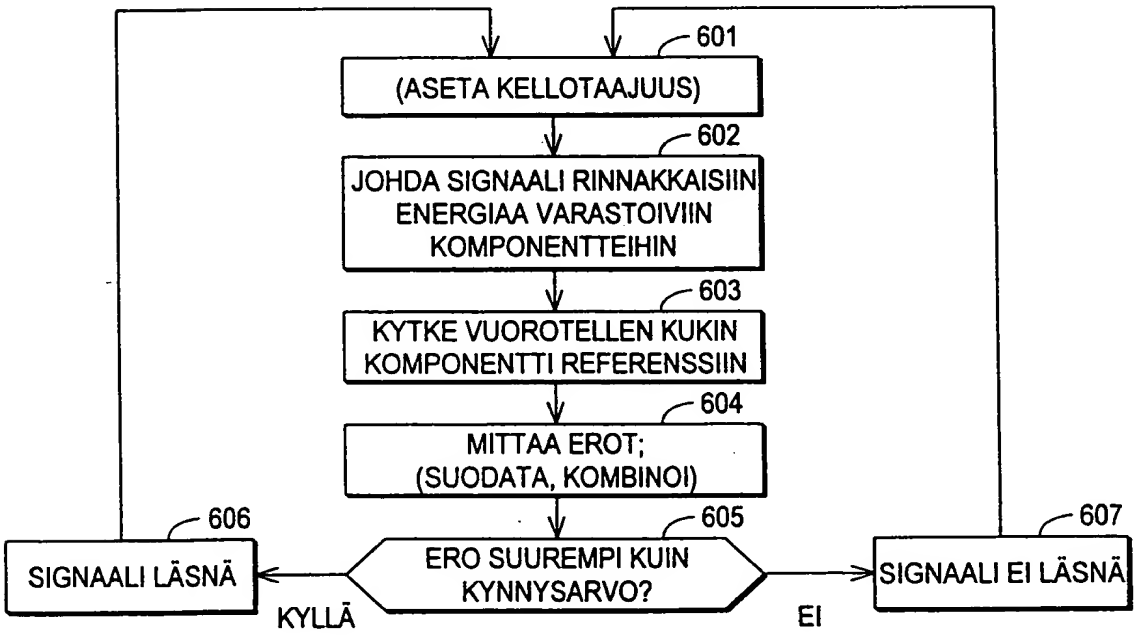
601
(ASETA KELLOTAAJUUS)
602
JOHDA SIGNAALI RINNAKKAISIIN ENERGIAA VARASTOIVIIN KOMPONENTTEIHIN
603
KYTKE VUOROTELLEN KUKIN KOMPONENTTI REFERENSSIIN
604
MITTAA EROT; (SUODATA, KOMBINOI)
606
605
607
SIGNAALI LÄSNÄ
ERO SUUREMPI KUIN KYNNYSARVO?
SIGNAALI EI LÄSNÄ
KYLLÄ
EI

Fig. 6

Claims

1. An electric device for detecting the presence of a signal of a certain frequency in a line connection (301), **characterized** in that it comprises
at least three energy-storing components (302, 303, 304, 305, 501, 502, 503, 504) connected in parallel to said line connection,
- switching means (306) between said energy-storing components and a certain reference for making a connection selectively from each energy-storing component to said reference,
- coupled to said switching means, means (CLK1, CLK2) for controlling said switching means at a predetermined frequency, and
- coupled to said energy-storing components, means (307, 308, 309) for measuring a certain quantity comparable to the energy stored from each energy-storing component.

2. A device according to Claim 1, **characterized** in that said switching means (306) are arranged to make a connection from each energy-storing component to the reference once during the cycle time of said signal to be detected.

3. A device according to Claim 2, **characterized** in that said energy-storing components are capacitances (302, 303, 304, 305), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the voltage difference between capacitances, and
- said reference is a certain standard potential.

4. A device according to Claim 3, **characterized** in that it comprises four capacitances (302, 303, 304, 305) as energy-storing components, whereby the means for measuring the voltage difference between capacitances are arranged to measure the voltage difference between the first (302) and third (304) capacitance and between the second (303) and fourth (305) capacitance. the order of the capacitances being the order in which the switching means are arranged to make a connection from each capacitance to the standard potential.

5. A device according to Claim 2, **characterized** in that said energy-storing components are inductances (501, 502, 503, 504), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the current difference between inductances, and

- said reference is a certain standard current (505).

6. A device according to Claim 1, **characterized** in that it also comprises filtering means (506, 507, 508, 509) for filtering said quantity comparable to the energy stored before the measurement of the quantity.

7. A method for detecting the presence of a signal of a certain frequency in a line connection, **characterized** in that it comprises steps in which
- the signal is led parallelly to at least three energy-storing components connected in parallel (602),
- each energy-storing component is regularly connected to a certain reference (603), and
- the value of a certain quantity comparable to the energy stored is measured from each energy-storing component (604, 605).

8. A method according to Claim 7, **characterized** in that each energy-storing component is connected to the reference once during the cycle time of the signal to be detected.

9. A method according to Claim 8, **characterized** in that an even number of energy-storing components are connected to the reference in turns during the cycle time of the signal to be detected in the order from one to N, where N is an even number, and in the measurement of the value of the quantity comparable to the energy stored the values related to the first and the $(N/2 + 1)^{th}$ component are compared, and similarly the values related to the second and the $(N/2 + 2)^{th}$ component and so forth up to the i^{th} and $(N/2 + i)^{th}$ component are compared, until $(N/2 + i) = N$.

10. A method according to Claim 7, **characterized** in that the value of said quantity comparable to the energy stored is also filtered before it is measured.

PATENT COOPERATION TREATY

PCT

REC'D 11 SEP 2000
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 47967/MB/MG	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI99/00395	International filing date *(day/month/year)* 11.05.1999	Priority date *(day/month/year)* 11.05.1998
International Patent Classification (IPC) or national classification and IPC7 H04Q 1/446		
Applicant TELLABS OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
07.12.1999	30.08.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Authorized officer Roland Landström / MRo Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00395

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-8, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☒ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. 1-10, filed with the letter of 26.06.2000,
Nos. _____, filed with the letter of _____.

☒ the drawings, ~~sheets~~/fig 1-6, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____,
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00395

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-10	YES
	Claims		NO
Inventive step (IS)	Claims	3-5,9	YES
	Claims	1-2,6-8,10	NO
Industrial applicability (IA)	Claims	1-10	YES
	Claims		NO

2. Citations and explanations

The invention claimed in amended independent claims 1 and 7 is intended to provide a device and a method for detecting the presence of a signal of a certain frequency.

The solution, not clearly revealed in claims 1 and 7, includes the steps etc. of coupling the signal to first terminals of at least three energy-storing components, regularly connecting the other terminal of each component to a certain reference, and measuring the energy stored in each component.

The following document was cited in the International Search Report:

A: US 4 127 824 A

Document A (column 1, line 40 - column 6, line 10, figures 1 - 5) discloses a device and a method for detecting the presence of a signal of a certain frequency at a terminal (11). The terminal is regularly connected to first terminals of three energy-storing capacitors (17, 18, 19) via switches (14, 15, 16). The other terminal of each capacitor is connected to a reference potential, which can be ground. The voltages appearing on the capacitors are coupled to measuring means (29, 34, 39). The switches are on for successive intervals wherein each interval is equal to one-third of the period of the frequency. The device etc. of claims 1 - 2 and 7 - 8 is equivalent to the device etc. known from document A since the signal in both cases is used to charge the capacitors in turn during the cycle time of the signal to be detected. Therefore, the invention claimed in claims 1 - 2 and 7 - 8 lacks an inventive step.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

Claims 6 and 10 suggest that a (low pass) filter is arranged at the input of the measuring means. This is an obvious variation to a person skilled in the art, especially as the advantages thus achieved can be readily contemplated in advance. Consequently, the invention claimed in claims 6 and 10 lacks an inventive step.

The invention claimed in claim 3 differs from what is known from document A, among other things, in that the device measures the voltage difference between the capacitors.

The invention claimed in claim 5 differs from what is known from document A, among other things, in that the energy-storing capacitors are replaced by energy-storing inductors, and that the device measures the current difference between the energy-storing inductors.

The invention claimed in claim 9 differs from what is known from document A, among other things, in that an even number of energy-storing components are used, and in the step of comparing in pairs the energy stored in the energy-storing components.

Therefore, the invention claimed in claims 3 - 5 and 9 is novel. It is also considered to involve an inventive step and have industrial applicability.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00395

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 1 and 7 are obscure since they do not reveal how the components are connected, the frequency used for controlling the switching means, the frequency used for the regular connection, and how the measurement is performed and used to determine the presence of a signal.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 47967	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/FI 99/00395	International filing date *(day/month/year)* 11 May 1999	(Earliest) Priority Date *(day/month/year)* 11 May 1998
Applicant TELLABS OY et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] Certain claims were found unsearchable (See Box I).

2. [ ] Unity of invention is lacking (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the abstract,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:
   Figure No. 3
   - [X] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00395

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 1/446
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4127824 A (ROBERT MCK,BENNETT, JR.,), 28 November 1978 (28.11.78), column 1, line 40 - column 6, line 10, figures 1-5	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 November 1999	29 -11- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Roland Landström/MN Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/11/99

International application No.
PCT/FI 99/00395

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4127824 A	28/11/78	AU 509600 B	15/05/80
		AU 3409478 A	20/09/79
		CA 1094174 A	20/01/81
		DE 2813628 A,C	12/10/78
		FR 2386951 A,B	03/11/78
		GB 1587301 A	01/04/81
		IL 54075 A	30/11/79
		JP 1185286 C	20/01/84
		JP 53123611 A	28/10/78
		JP 58020495 B	23/04/83
		NL 182525 B,C	16/10/87
		NL 7803557 A	06/10/78
		SE 439565 B,C	17/06/85
		SE 7802358 A	05/10/78
		ZA 7800872 A	31/01/79

PATENTTI- JA REKISTERIHALLITUS
Patentti- ja innovaatiolinja

TUTKIMUSRAPORTTI

PATENTTIHAKEMUS NRO	LUOKITUS
981038	H04M 15/00, 3/22, H03H 19/00

TUTKITTU AINEISTO

Patenttijulkaisukokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US) tutkitut luokat:

H03H 11/04, H04M 15/00

sekä lisäksi tutkitut FI-luokat:

H03H 7/00, 7/01, 11/00, 11/02, 19/00, H04M 1/00, 1/24, 1/27, 1/30, 1/50, 1/56, 1/57, 3/00, H04M 3/42

Tiedonhaut ja muu aineisto

Seuraavat tietokannat: EPODOC, WPI, PAJ

VIITEJULKAISUT

Kategoria*)	Julkaisun tunnistetiedot	Koskee vaatimuksia
X	US 4769612 (H03H 19/00)	1 - 10
X	US 4315227 (H03H 19/00)	- " -
X	US 5331218 (H03K 5/00)	- " -
X	WO 85/01623 (H03H 19/00)	- " -
X	US 4494082 (H04B 3/14)	- " -
X	EP 0413472A2 (H03D 3/22)	- " -
X	US 5659269 (H03L 7/093)	- " -

*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna
Y Patentoitavuuden kannalta merkittävä julkaisu, kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu
A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este

Päiväys	Tutkija
29. 4. 1999	Tino Huttunen

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 1/446

A2

(11) International Publication Number: WO 99/59347

(43) International Publication Date: 18 November 1999 (18.11.99)

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(22) International Filing Date: 11 May 1999 (11.05.99)

(30) Priority Data:
981038 11 May 1998 (11.05.98) FI

(71) Applicant *(for all designated States except US)*: TELLABS OY [FI/FI]; Sinikalliontie 7, FIN–02630 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: HURME, Harri [FI/FI]; Kaskenkaatajantie 18 C, FIN–02100 Espoo (FI). TAMMINEN, Timo, M. [FI/FI]; Puustellinpolku 8 C 8, FIN–00410 Helsinki (FI). KOSKELA, Jari [FI/FI]; Mäkelänkatu 4d A 6, FIN–00510 Helsinki (FI).

(74) Agent: BERGGREN OY AB; P.O. Box 16, FIN–00101 Helsinki (FI).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

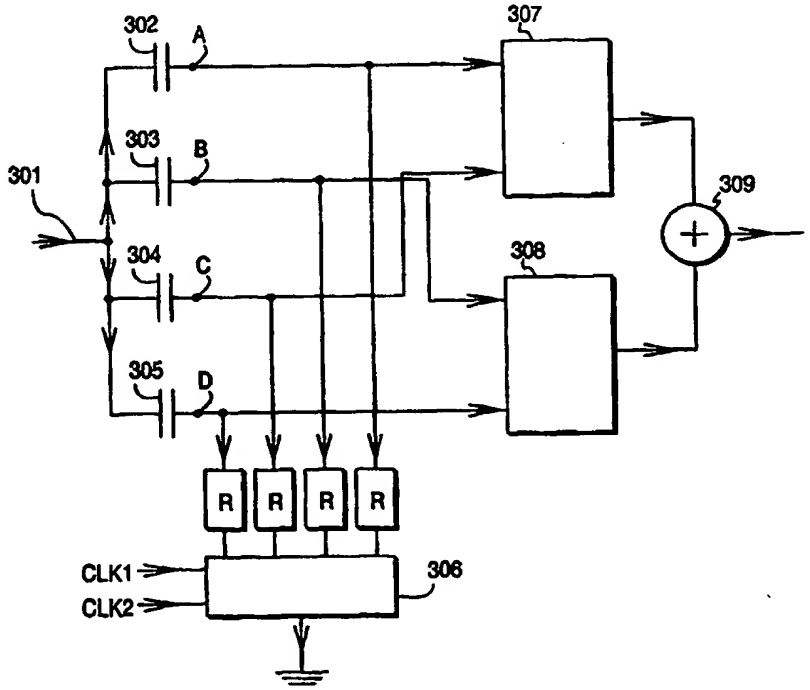
Published

In English translation (filed in Finnish).
Without international search report and to be republished upon receipt of that report.

(54) Title: METHOD AND DEVICE FOR DETECTING A SIGNAL HAVING A CERTAIN FREQUENCY

(57) Abstract

An electric device is intended for detecting the presence of a signal having a certain frequency (401) in a line connection (301). It comprises at least three energy–storing components (302, 303, 304, 305, 501, 502, 503, 504) connected in parallel to the line connection, switching means (306) for making a connection selectively from each energy–storing components to a certain reference, means (CLK1, CLK2) for controlling the switching means at a predetermined frequency, and means (307, 308, 309) for measuring a certain quantity comparable to the energy stored from each energy–storing component.



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Method and device for detecting a signal having a certain frequency

This invention relates to signal detection or determining whether a signal oscillating at a certain frequency occurs in a certain line connection or not. More particularly, the invention relates to signal detection in an analogue telephone line.

In data transfer technology, there is often a need to detect whether a voltage and/or current signal having a certain frequency occurs in a certain line connection or not. An example of this is a telephone system in which an analogue telephone exchange sends invoicing pulses as short signal pulses having a frequency of 12 kHz or 16 kHz. Another device of the telephone system, such as an OLIC (office line interface circuit), which simulates an analogue telephone,must be able to detect the invoicing pulses correctly, which means that all invoicing pulses must be detected, but other signals must not be allowed to cause a faulty detection.

A conventional method for detecting a signal of a certain frequency is to use two circuit devices 101 and 102 connected in series as in Figure 1, of which devices the first one in relation to the direction in which the signal moves is a passband filter or a corresponding frequency-sensitive circuit device 101, and the second one is a level indicator 102 which is not frequency-sensitive. The filter 101 has a certain frequency response, in which the center frequency of the passband is the same as the desired signal frequency to be detected. The status of the output of the level indicator 102 is active when a signal of a sufficiently high level comes through the filter 101, and otherwise passive. The arrangement shown in Figure 1 entails many drawbacks. It may be laborious to make the frequency response of the filter 101 as desired, and it may require the use of a large and/or complicated filter. It is difficult to move the passband of the passband filter for a remarkable distance, and therefore, if the same device should be used according to selection to detect a signal of either 12 kHz or 16 kHz, it may be necessary to change the filter 101 in connection with the selection.

Patent application FI-944857 discloses a more advanced arrangement as shown in Figure 2 for detecting a signal of a certain frequency. The voltage signal running in the twin cable 201 is amplified in the amplifier 202 and fed via a decoupling capacitor 203 to a demultiplexer 204, which is controlled by a clock signal CLK. The demultiplexer 204 controlled by the clock signal switches the voltage signal received cyclically to only one of the outputs 205 to 208 at a time. The low pass

filters 209 to 212 filter the voltage signal connected to each output substantially as direct voltage. The comparator 213 makes comparisons between the filtered direct voltage signals and gives an output signal det0, if there is a sufficient difference between the outputs of certain filters.

In the solution illustrated in Figure 2 the idea is that when the frequency of the clock signal CLK is exactly four times the frequency of the signal to be detected, the demultiplexer 204 has time to connect the voltage signal once to each output during one cycle of the signal to be detected. The part of the signal to be detected which is connected to a certain output remains unchanged from one cycle to another. Thus the filters 209 to 212 produce direct voltages of different levels according to which part of the waveform of the signal to be detected is connected to which output. The comparator 213 detects that the voltages produced by the filters 209 to 212 differ from each other. If the twin cable 201 does not contain the signal which was to be detected, but it contains a signal of another frequency instead, the part of the waveform of the signal connected to a certain output changes from one cycle to another. Thus a variable voltage signal which does not proceed through the filter is coupled to each filter 209 to 212. The comparator 213 "sees" the outputs of all filters substantially similar, whereby it does not give an output signal.

The arrangement shown in Figure 2 entails the drawback that the signal to be detected has to be led through both a demultiplexer and filters, which may cause a remarkable attenuation of the signal and losses, which cause warming up of the circuit during use. With regard to the operation of the circuit it is important that the frequency responses of filters 209 to 212 are very similar, which requires the use of relatively expensive, tuned filters. In addition, the arrangement is only suitable for detecting voltage signals.

It is an objective of the present invention to provide a method and arrangement for detecting a signal of a certain frequency in which the above described drawbacks of the prior art can be reduced or eliminated.

The objectives of the invention are achieved by connecting the signal to be detected to parallel, energy-storing components, which are synchronized and the outputs of which can be compared in different ways.

The device according to the invention is characterized in that it comprises
- at least three energy-storing components connected in parallel to a line connection.

- switching means for making a connection selectively from each energy-storing component to a certain reference,
- means for controlling the switching means at a predetermined frequency, and
- means for measuring a certain quantity comparable to the energy stored from each energy-storing component.

The invention also relates to a method, which is characterized in that it comprises steps in which
- the signal is led to at least three energy-storing components connected in parallel,
- each energy-storing component is regularly connected to a certain reference, and
- the value of a certain quantity comparable to the energy stored is measured from each energy-storing component.

According to the invention, a signal which may contain a signal to be detected is connected to parallel, energy-storing components, such as capacitances or inductances, the number of which is not limited as such, but is four in the preferred embodiment of the invention. The operation of the energy-storing components is synchronized so that the signal produced in each one of them is deviated by connecting the output for a certain time to a pre-determined deviating standard level. The switching moments when the deviation takes place, change cyclically at a certain frequency from one energy-storing component to another. The deviation frequency is comparable to the frequency of the signal to be detected. If the signal to be detected is present, the deviation causes standard-sized differences between the outputs of certain energy-storing components defined in pairs. The standard-sized differences are detected by the comparators connected to the outputs. The comparators can be connected together in different ways in order to improve the clarity of the detection.

In the solution according to the invention, the signal to be detected does not proceed through the demultiplexer as in the solution described in the application FI-944857, and the invention does not necessarily require the use of filters on the signal path. The frequency to be detected can be easily selected by changing the above mentioned deviation frequency.

In the following, the invention will be described in more detail with reference to the examples of preferred embodiments and the accompanying drawings, in which

Figure 1 shows a prior art detector,

Figure 2 shows another prior art detector,

Figure 3 shows a preferred embodiment of the invention,

Figures 4a and 4b show certain voltage forms in the embodiment of Figure 3,

Figure 5 shows another preferred embodiment of the invention, and

Figure 6 illustrates a method according to the invention.

Above in connection with the description of the prior art, reference was made to Figures 1 and 2, and in the following description of the invention and its preferred embodiments reference will be made mostly to figures 3 to 6. In the figures, the same reference numbers are used for corresponding parts.

Figure 3 shows a simplified block diagram, in which a preferred embodiment of the invention suitable for the detection of the voltage signal is illustrated. The signal which is examined for the presence of the signal to be detected, is led to a circuit shown in Figure 3 along line 301, and it is branched to parallel capacitances 302 to 305 of the same size. From one side of each capacitance, there is a connection via a block denoted with R and a certain switching arrangement to the reference potential, which in the embodiment shown in the figure is the ground potential. All four switching arrangements are implemented by means of a multiplexer 306, the operation of which is controlled by the clock signals CLK1 and CLK2. The blocks denoted with R can be simply resistances or they can contain more complicated arrangements. However, all R-blocks are substantially similar. From the capacitances 302 and 304 there is also a connection to the comparator 307, and from the capacitances 303 and 305 there is a connection to the comparator 308. The outputs of the comparators 307 and 308 are summed in the adder 309, the output signal of which is the output signal of the whole circuit arrangement.

For the description of the coupling shown in Figure 3, it is at first assumed that the signal coming along the line 301 is a pure sine wave having exactly the frequency which is to be detected. It is also assumed that the signal to be detected is a pure sinusoidal alternating voltage, whereby its time average is the same as the reference potential shown in Figure 3. The capacitances 302 to 305 are dimensioned high enough to allow the voltage signal to be detected pass through them, so that if there were no connection between the capacitances and the reference potential, an identical sinusoidal voltage would be detected at each point A, B, C and D. The operation of the multiplexer 306 is controlled by the clock signal CLK1 and/or CLK2 so that during one cycle of the signal to be detected there is a connection once from each point A, B, C and D through a corresponding R-block to the

reference potential. Figure 4a shows a timing of the operation of the multiplexer 306 by way of example. In this example, the waveform 401 depicts the voltage signal at the frequency to be detected, and the letters A, B, C and D denote the times during which a connection from each point A, B, C and D through a corresponding R-block to the reference potential exists.

It is beneficial to the operation of the invention if the input impedance of the R-blocks is substantially smaller than the input impedance of the comparators 307 and 308. In that case, the above described synchronized coupling causes different amounts of electric energy to be stored in the capacitances 302 to 305 depending on at which moment of the cycle time of the signal to be detected the capacitance is connected via the R-block to the ground potential. From Figure 4a it is seen, for example, that the connection from point A or capacitance 302 through the corresponding R-block to the ground potential exists when the voltage of the signal to be detected is nearly at the highest, and the connection from point C or capacitance 304 through a corresponding R-block to the ground potential exists when the voltage of the signal to be detected is nearly at the lowest. Thus the electric energy stored in the capacitances 302 and 304 is seen in that the potential of point A is continuously by a certain constant higher than the potential of point C. The situation can also be described by saying that the direct voltage component integrated into the capacitance 302 is larger than the corresponding direct voltage component integrated into the capacitance 304.

It is important to note that in the embodiment of Figure 3 the capacitances 302 and 305 do not function as integrators in the sense that they would constitute the time integral of the signal to be detected. The integration mentioned above means that each capacitance stores a certain amount of electromagnetic energy from the signal to be detected, and the amount of the energy depends on at which point of the cycle of the signal to be detected and led to the capacitance the connection to the reference potential is made. In Figure 4b, curve 410 depicts the potential of point A and curve 411 depicts the potential of point C. Thus a sinusoidal voltage signal is detected between points A and C and the ground potential, having the same frequency as the signal to be detected, but the voltage signals detected at different points are deviated in relation to one another by a certain constant voltage difference. By examining Figure 4a it can be concluded that the same phenomenon would occur between points B and D, but weaker, because at the points of time denoted by B and D when the connection between the capacitance 303 or 305 and

the ground potential exists, the absolute value of the signal to be detected is relatively close to zero.

The signals according to Figure 4b can be led to the comparator 307 according to Figure 3, because the output of the comparator only depends on the potential difference between its two inputs and not on the absolute value of the potential of either input. A comparator like this is generally characterized by saying that it is immune to common-mode signals. Thus the output of the comparator 307 is active when the direct voltage components integrated into the capacitances 302 and 304 differ from each other by more than the threshold value set for the comparator 307. In the same way, the output of the comparator 308 is active when the direct voltage components integrated into the capacitances 303 and 305 differ from each other by more than the threshold value set for the comparator 308, which is preferably the same as the threshold value set for the comparator 307. Summing the output signals of the comparators 307 and 308 in the adder 309 causes the output of the whole circuit to be active if the output signal of at least one of the comparators is active. The active and passive mode of a certain signal can be defined suitably in each connection; in digital circuits applying conventional logic the active mode generally corresponds to the bit value "1", which is described by a certain positive voltage, and the passive mode corresponds to the bit value "0", which is described by a voltage close to the ground potential.

It cannot be known in advance how the switching cycle of the multiplexer 306 relates to the phase of the signal to be detected. Figures 4a and 4b relate to a situation in which the direct voltage component integrated into the capacitance 302 is larger than the direct voltage component integrated into the capacitance 304, but a relative transition of half a cycle of the signal to be detected between the signal and the switching cycle of the multiplexer would change the situation exactly the opposite. Because of this, it is advantageous to implement the comparators 307 and 308 as so-called window comparators, which have an active output when the absolute value of the difference between the input signals exceeds a certain threshold value, regardless of which one of the input signals has a higher value.

For understanding the frequency sensitivity of the arrangement according to Figure 3 it will now be studied what will happen if the signal coming along the line 301 does not contain a signal component at the frequency to be detected. To make it simple it can be assumed at first that the signal coming along line 301 is pure sine wave at a frequency other than the one to be detected. If this other frequency differs only a little from the frequency to be detected, the comparator 307 (likewise 308)

detects a sinusoidal voltage difference between its inputs, the frequency of which is the same as the absolute value of the difference between the frequency to be detected and the frequency of the signal coming along the line 301. The amplitude of the voltage difference depends on the dimensioning of the capacitances 302 to 305 and the R-blocks, or more exactly, the time constant determined on the basis of the dimensioning, which regulates the integration of the direct voltage component into the capacitances 302 to 305. The threshold value set for the comparators 307 and 308 determines how close to the frequency to be detected the frequency of the signal coming along the line 301 must be for at least one of the comparators to give an active output signal.

If the frequency of the signal coming along the line 301 differs substantially from the frequency to be detected, the switching cycle of the multiplexer 306 is spurious in relation to the signal, or the moments at which the connection from each capacitance to the reference potential exists do not occur with any regularity in relation to the waveform of the signal coming along the line 301. Thus only an insignificantly small direct voltage component is integrated into each capacitance 302 - 305, and the output of neither of the comparators 307 and 308 is active.

Figure 5 depicts an alternative embodiment of the invention, in which the energy-storing components 501 - 504 are inductances, in which the electric energy is stored as current and not as voltage. Thus the reference potential (ground potential in Figure 3) must be replaced by a constant current generator 505. Figure 5 also shows the low pass filters 506 - 509 between the energy-storing components 501 - 504 and the comparators 307 and 308. Filters can be used to improve the operation of a device according to the invention especially when the comparators 307 and 308 are not sufficiently immune to common-mode signals. Corresponding filters could also be used in the solution shown in Figure 3.

The embodiments of the invention described above should naturally only be seen as examples, and they do not have a limiting effect on the invention. It should be especially noted that the invention does not require that the switches which in Figures 3 and 5 are switched to the conductive mode with a common multiplexer 306 would be switched in a way that only one switch at a time conducts. In other words, the connection time of one switch can also be shorter or longer than one Nth part of the cycle time of the signal to be detected, where N is the number of energy-storing components (in Figures 3 and 5 the value of N is four); thus it is possible that several switches at a time conduct or that there are moments when none of the switches conduct. The voltage or current signals produced by the energy-storing

components can be combined in many ways before they are led to the comparators, by using a so-called resistance matrix, for example. The number of parallel, energy-storing components is at least three, in which case at least three comparators are needed to compare the voltage or current differences of all the three possible pairs.

The frequency of the clock signals used to control the multiplexer should be programmable, whereby the device can be applied to detect a signal of almost any frequency by changing the frequency of the clock signal only. The aliasing phenomenon, known from sampling theory, means that a certain sampling frequency (a certain clock frequency in the present invention) causes the detection of both the signal which was to be detected and its harmonic frequencies. If the harmonic frequencies are harmful, the device according to the invention can be equipped with an anti-alias filter in a manner known as such from sampling theory. On the other hand, some applications may even benefit from the fact that the same device can detect both a certain basic frequency and its harmonic multiples.

The threshold values used by the comparators can also be made programmable. Furthermore, it is possible to present a modified embodiment in which the output signal of the whole device is led in a known manner as feedback to influence the values of the threshold signals used by comparators, whereby the hysteresis phenomenon can be utilized in the operation of the device.

The device according to the invention can be manufactured from cheap, ordinary separate components or it can be implemented as part of an integrated circuit or as an integrated circuit on its own.

Figure 6 shows the method according to the invention as a flowchart. Step 601, setting the clock frequency, can be carried out always when there is a need to set a new signal frequency to be detected; otherwise step 601 can be ignored. In step 602 the signal is led to parallel capacitances or other energy-storing components, in step 603 connections are made in turns from parallel capacitances or the like to the reference potential or current, and in step 604 the voltage or current differences are measured, which may include filtering and combining. In step 605 it is determined whether a difference which is larger than the set threshold value has been found in the measurement. Depending on the result, return to the start takes place through step 606 or 607. If hysteresis is used to regulate the threshold values used by the comparators, a certain feedback from steps 606 and 607 to step 605 is also added to the flowchart.

Claims

1. An electric device for detecting the presence of a signal of a certain frequency in a line connection (301), **characterized** in that it comprises
at least three energy-storing components (302, 303, 304, 305, 501, 502, 503, 504) connected in parallel to said line connection,
- switching means (306) for making a connection selectively from each energy-storing component to a certain reference,
- means (CLK1, CLK2) for controlling said switching means at a predetermined frequency, and
- means (307, 308, 309) for measuring a certain quantity comparable to the energy stored from each energy-storing component.

2. A device according to Claim 1, **characterized** in that said switching means (306) are arranged to make a connection from each energy-storing component to the reference once during the cycle time of said signal to be detected.

3. A device according to Claim 2, **characterized** in that said energy-storing components are capacitances (302, 303, 304, 305), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the voltage difference between capacitances, and
- said reference is a certain standard potential.

4. A device according to Claim 3, **characterized** in that it comprises four capacitances (302, 303, 304, 305) as energy-storing components, whereby the means for measuring the voltage difference between capacitances are arranged to measure the voltage difference between the first (302) and third (304) capacitance and between the second (303) and fourth (305) capacitance, the order of the capacitances being the order in which the switching means are arranged to make a connection from each capacitance to the standard potential.

5. A device according to Claim 2, **characterized** in that said energy-storing components are inductances (501, 502, 503, 504), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the current difference between inductances, and
- said reference is a certain standard current (505).

6. A device according to Claim 1, **characterized** in that it also comprises filtering means (506, 507, 508, 509) for filtering said quantity comparable to the energy stored before the measurement of the quantity.

7. A method for detecting the presence of a signal of a certain frequency in a line connection, **characterized** in that it comprises steps in which
- the signal is led to at least three energy-storing components connected in parallel (602),
- each energy-storing component is regularly connected to a certain reference (603), and
- the value of a certain quantity comparable to the energy stored is measured from each energy-storing component (604, 605).

8. A method according to Claim 7, **characterized** in that each energy-storing component is connected to the reference once during the cycle time of the signal to be detected.

9. A method according to Claim 8, **characterized** in that an even number of energy-storing components are connected to the reference in turns during the cycle time of the signal to be detected in the order from one to N, where N is an even number, and in the measurement of the value of the quantity comparable to the energy stored the values related to the first and the $(N/2 + 1)^{th}$ component are compared, and similarly the values related to the second and the $(N/2 + 2)^{th}$ component and so forth up to the i^{th} and $(N/2 + i)^{th}$ component are compared, until $(N/2 + i) = N$.

10. A method according to Claim 7, **characterized** in that the value of said quantity comparable to the energy stored is also filtered before it is measured.

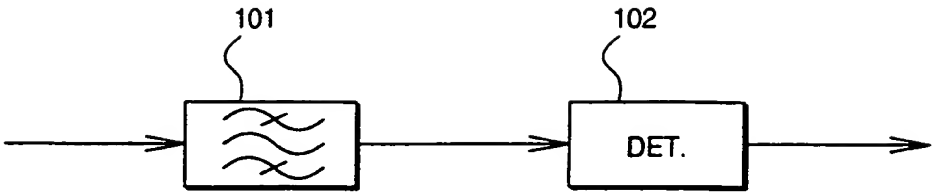

Fig. 1
PRIOR ART

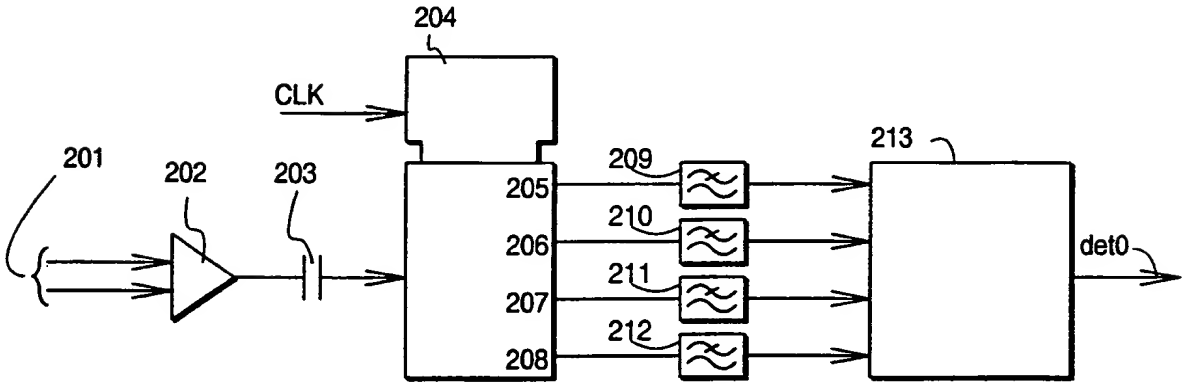

Fig. 2
PRIOR ART

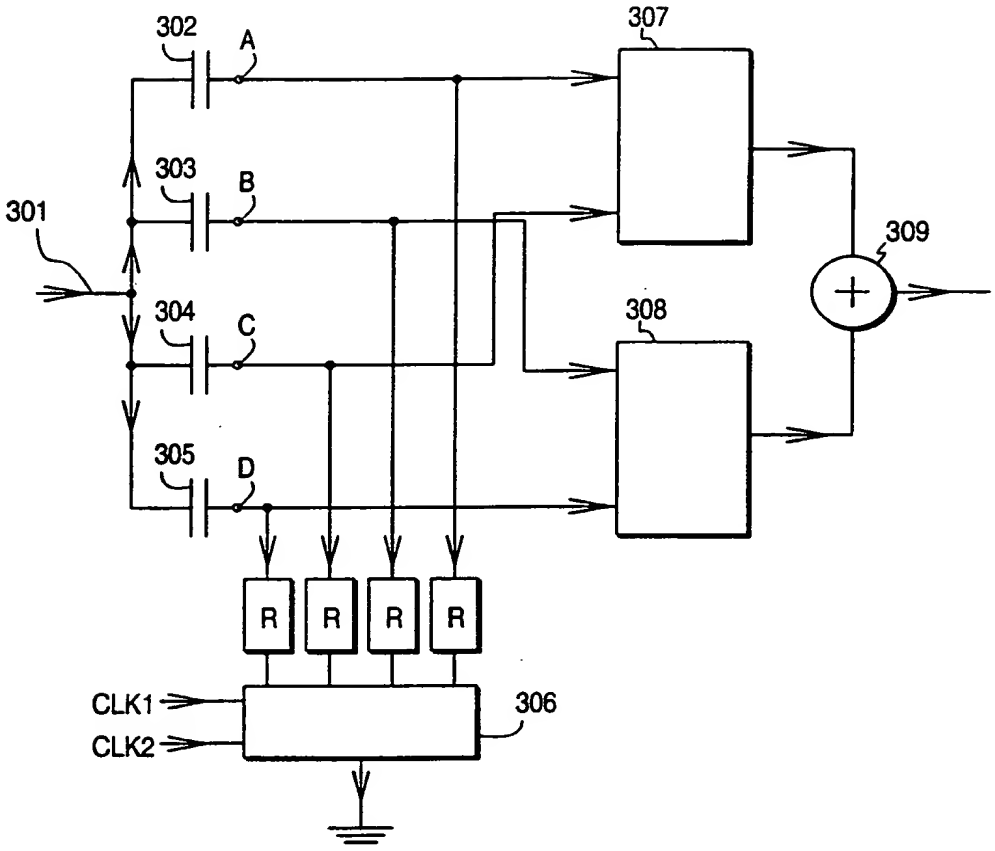

Fig. 3

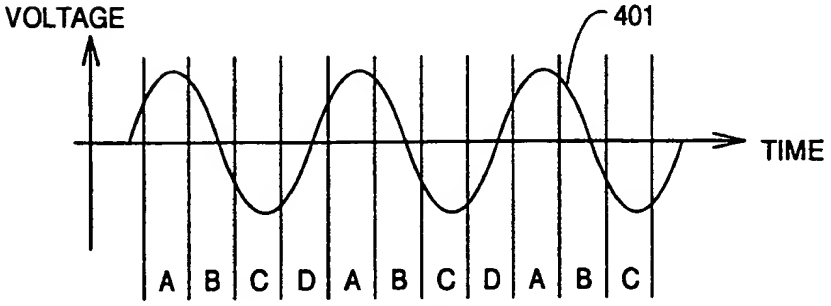

Fig. 4a

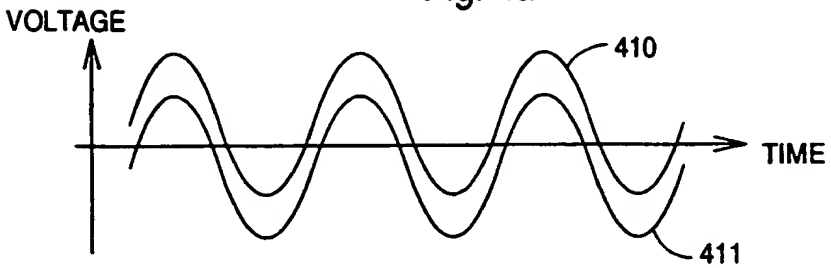

Fig. 4b

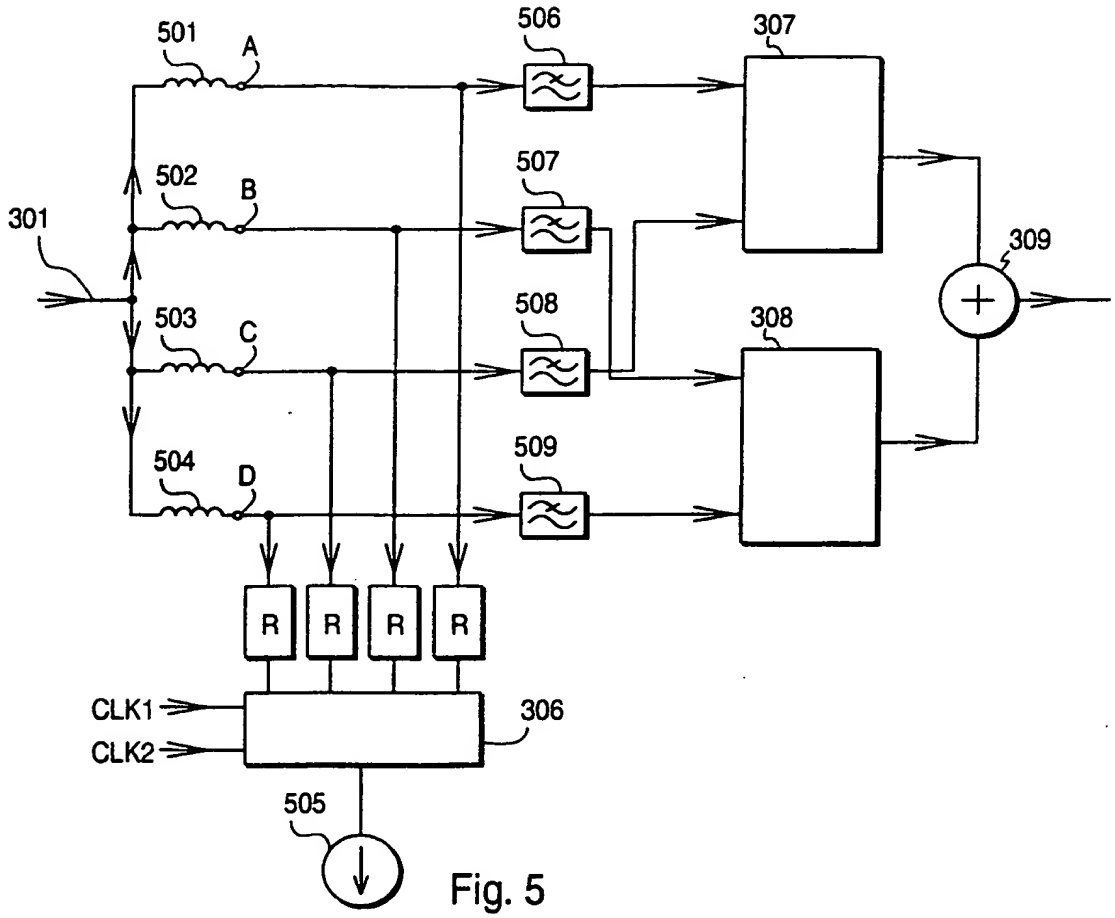
501
A
506
307
502
B
507
301
309
503
C
508
308
504
D
509
R
R
R
R
CLK1
CLK2
306
505

Fig. 5

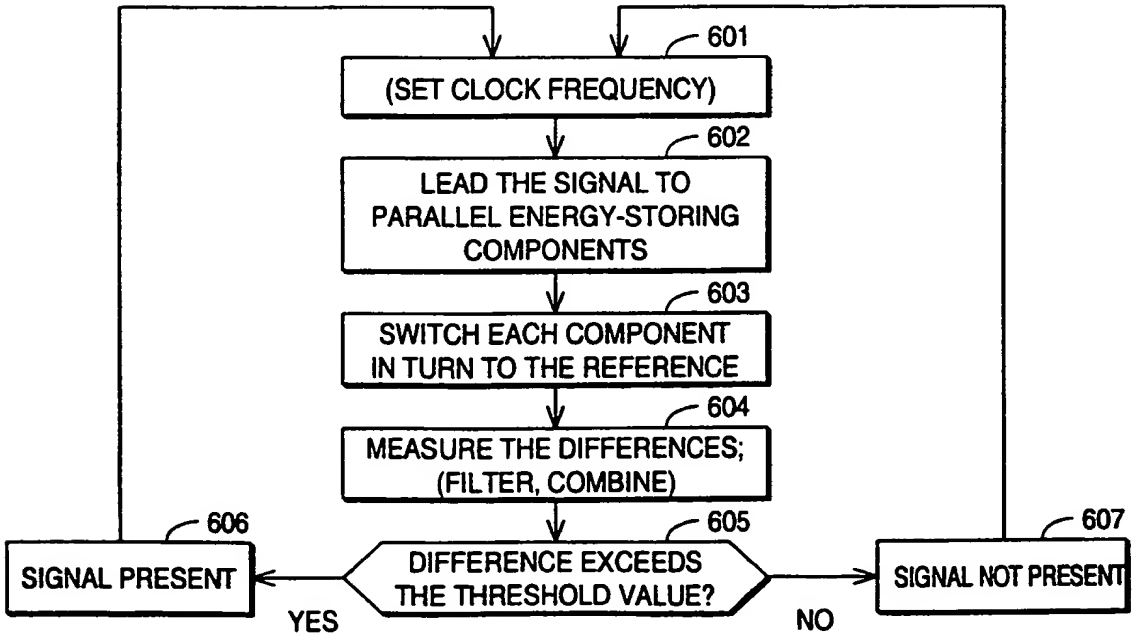
601
(SET CLOCK FREQUENCY)
602
LEAD THE SIGNAL TO PARALLEL ENERGY-STORING COMPONENTS
603
SWITCH EACH COMPONENT IN TURN TO THE REFERENCE
604
MEASURE THE DIFFERENCES; (FILTER, COMBINE)
606
605
607
SIGNAL PRESENT
DIFFERENCE EXCEEDS THE THRESHOLD VALUE?
SIGNAL NOT PRESENT
YES
NO

Fig. 6

Claims

1. An electric device for detecting the presence of a signal of a certain frequency in a line connection (301), **characterized** in that it comprises
at least three energy-storing components (302, 303, 304, 305, 501, 502, 503, 504) connected in parallel to said line connection,
- switching means (306) between said energy-storing components and a certain reference for making a connection selectively from each energy-storing component to said reference,
- coupled to said switching means, means (CLK1, CLK2) for controlling said switching means at a predetermined frequency, and
- coupled to said energy-storing components, means (307, 308, 309) for measuring a certain quantity comparable to the energy stored from each energy-storing component.

2. A device according to Claim 1, **characterized** in that said switching means (306) are arranged to make a connection from each energy-storing component to the reference once during the cycle time of said signal to be detected.

3. A device according to Claim 2, **characterized** in that said energy-storing components are capacitances (302, 303, 304, 305), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the voltage difference between capacitances, and
- said reference is a certain standard potential.

4. A device according to Claim 3, **characterized** in that it comprises four capacitances (302, 303, 304, 305) as energy-storing components, whereby the means for measuring the voltage difference between capacitances are arranged to measure the voltage difference between the first (302) and third (304) capacitance and between the second (303) and fourth (305) capacitance, the order of the capacitances being the order in which the switching means are arranged to make a connection from each capacitance to the standard potential.

5. A device according to Claim 2, **characterized** in that said energy-storing components are inductances (501, 502, 503, 504), whereby
- said means (307, 308, 309) for measuring the quantity comparable to the energy stored comprise means (307, 308) for measuring the current difference between inductances, and

- said reference is a certain standard current (505).

6. A device according to Claim 1, **characterized** in that it also comprises filtering means (506, 507, 508, 509) for filtering said quantity comparable to the energy stored before the measurement of the quantity.

7. A method for detecting the presence of a signal of a certain frequency in a line connection, **characterized** in that it comprises steps in which
- the signal is led parallelly to at least three energy-storing components connected in parallel (602),
- each energy-storing component is regularly connected to a certain reference (603), and
- the value of a certain quantity comparable to the energy stored is measured from each energy-storing component (604, 605).

8. A method according to Claim 7, **characterized** in that each energy-storing component is connected to the reference once during the cycle time of the signal to be detected.

9. A method according to Claim 8, **characterized** in that an even number of energy-storing components are connected to the reference in turns during the cycle time of the signal to be detected in the order from one to N, where N is an even number, and in the measurement of the value of the quantity comparable to the energy stored the values related to the first and the $(N/2 + 1)^{th}$ component are compared, and similarly the values related to the second and the $(N/2 + 2)^{th}$ component and so forth up to the i^{th} and $(N/2 + i)^{th}$ component are compared, until $(N/2 + i) = N$.

10. A method according to Claim 7, **characterized** in that the value of said quantity comparable to the energy stored is also filtered before it is measured.

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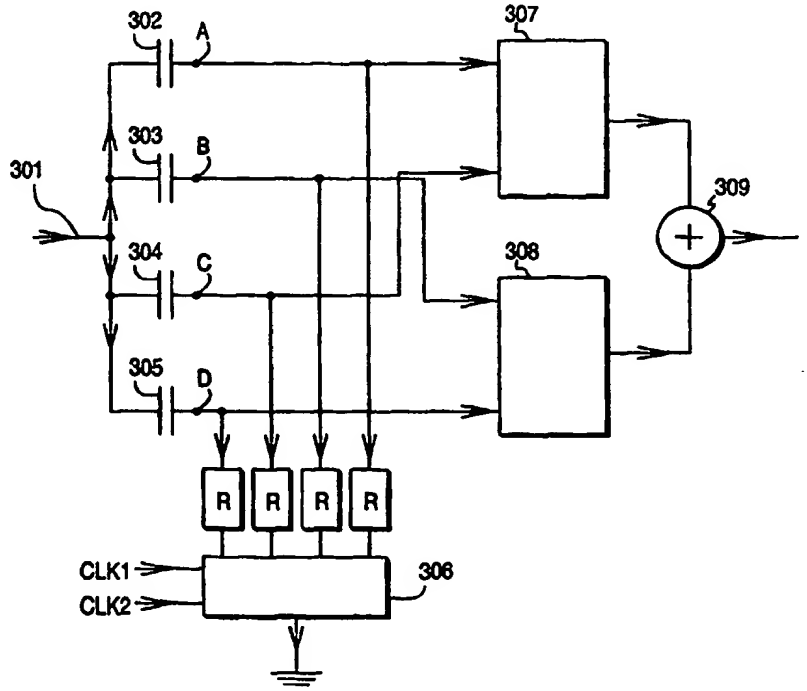
(54) Title: METHOD AND DEVICE FOR DETECTING A SIGNAL HAVING A CERTAIN FREQUENCY

(57) Abstract

An electric device is intended for detecting the presence of a signal having a certain frequency (401) in a line connection (301). It comprises at least three energy–storing components (302, 303, 304, 305, 501, 502, 503, 504) connected in parallel to the line connection, switching means (306) for making a connection selectively from each energy–storing components to a certain reference, means (CLK1, CLK2) for controlling the switching means at a predetermined frequency, and means (307, 308, 309) for measuring a certain quantity comparable to the energy stored from each energy–storing component.



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00395

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 1/446
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4127824 A (ROBERT MCK,BENNETT, JR.,), 28 November 1978 (28.11.78), column 1, line 40 - column 6, line 10, figures 1-5	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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